Third, and of special relevance here, the incumbent LECs are planning their networks on an integrated basis, making sure that they meet the needs of their affiliates but making no comparable effort to understand -- much less fulfill -- the needs of nonaffiliates. True nondiscrimination means accommodating the needs of the competitive LEC as much as those of the separate affiliate, before the decisions are made. The Commission should make clear that the nondiscrimination requirement is *not* satisfied when nonaffiliated competitive LECs are limited exclusively to functionalities that have been requested by, and made available to, incumbent LEC affiliates (and were specifically designed to be uniquely beneficial to the incumbent LEC affiliate). If the incumbent LEC is willing to do what is necessary to meet its affiliate's needs and to position itself and its affiliate to offer both voice and data services to consumers, then true nondiscrimination would require that the incumbent LEC be equally forthcoming in fully meeting the needs of nonaffiliates, so that they can enjoy comparable efficiencies in offering both voice and data services to consumers. It also necessitates that all critical loop functionalities be owned and operated by incumbent LECs, not their "separate" affiliates.

Critically, the nondiscrimination requirement must also apply to the planning process, and to the decisions an incumbent LEC makes about what capabilities will be offered to its affiliate and to nonaffiliates.[115] An incumbent LEC cannot be permitted to choose which technologies to use, and what capabilities to make available, in a manner that is uniquely advantageous to the affiliate. Competitive LECs are also entitled to have their own unique needs considered and met on an equivalent basis. Here again true nondiscrimination requires that such decisions are made with as much concern for the desires and needs of nonaffiliates as for those

[115] *Non-Accounting Safeguards Order* ¶¶ 210-12.

of the affiliate.[116] Again, this means that all features, functions, and capabilities of the loop must be arranged by the ILEC, not by any unregulated affiliate.

Nondiscrimination also means making sure that competitive LECs are as knowledgeable about changes in the network -- their nature, their location, and their timing -- as is the affiliate. No disinterested observer would claim that the incumbent LECs have been nondiscriminatory in their network planning, or in divulging the results of their network planning. Indeed, the 1996 Act plainly requires ILECs to apprise CLECs of changes to the network that would impact their services. Under section 251(c)(5), ILECs must "provide reasonable public notice of changes in the information necessary for the transmission and routing of services using that local exchange carrier's facilities or networks, as well as of any other changes that would affect the interoperability of those facilities or networks."[117] In addition, the Commission's rules implementing this provision state that the network disclosure requirement is a "broad standard" that includes changes to network configuration.[118] Obviously, the deployment of next generation architecture constitutes exactly the type of change that the Commission anticipated would trigger such advance notice requirements.[119]

III. THE COMMISSION SHOULD ADOPT NATIONAL RULES GOVERNING SPACE PROVISIONING RESERVATION POLICIES.

As the Commission has recognized and as the record in these proceedings clearly demonstrates, national space provisioning and reservation standards are necessary to ensure that

[116] *Id.* ¶ 211.

[117] 47 U.S.C. § 251(c)(5).

[118] *Local Competition Second Report and Order* ¶ 182.

[119] *Id.* ("[e]xamples of network changes that would trigger public disclosure obligations include, but are not limited to, changes that affect: transmission; signaling standards; call routing; network configuration; logical elements; electronic interfaces; data elements; and transactions that support ordering, provisioning, maintenance and billing").

incumbent LECs comply with their statutory obligation to provide collocation on terms and conditions that are "just, reasonable, and nondiscriminatory" pursuant to Section 251(c)(6).[120] Indeed, it has been repeatedly demonstrated that "incumbent LECs in many states will continue to delay unreasonably competitive LECs' build-out of their facilities" in the absence of national provisioning rules.[121] National standards mandating the "[t]imely provisioning of physical collocation space [are] critically important to telecommunications carriers' ability to compete effectively" and to the development of competition generally.[122] Accordingly, the Commission should adopt national standards to curb incumbent LECs' continuing ability to stifle competition through space provisioning and reservation policies.

A. Provisioning Intervals

In the FNPRM (¶ 114), the Commission seeks comment on whether it "should specify an overall maximum collocation provisioning interval shorter than 90 calendar days or shorter intervals for particular types of collocation arrangements," such as cageless collocation, modifications to existing collocation arrangements, or collocation within remote incumbent LEC structures. While AT&T believes that the 90-day interval proposed by the Commission is generally appropriate for caged collocation and certain other collocation arrangements in unconditioned space, AT&T submits that shorter intervals should be adopted to reflect the substantial reduction in the amount of work (and time) required to provide collocation in conditioned space, to provision cageless collocation arrangements, and to complete basic

[120] *Collocation Order* at ¶ 13; *Local Competition Order* at ¶ 558.

[121] *FNPRM* at ¶ 22. *See also,* e.g., *UNE Remand Order*, 15 FCC Rcd. at ¶¶ 90-91 (concluding that incumbent LECs can take advantage of collocation provisioning delays to lock-up customers prior to competitive entry);

[122] *FNPRM* at ¶ 22.

augmentations and modifications to existing physical collocations. Accordingly, AT&T proposes the default rules set out below.

1. Cageless Collocation in Conditioned Space. The Commission should adopt a 60-day interval for provision of cageless collocation when conditioned space is available. Because the incumbent avoids both preparing (conditioning) space for the collocation as well as installing a cage, incumbent LECs require substantially less time to complete such collocation arrangements.

Indeed, state commission orders, industry practice, and numerous comments and submissions in these proceedings provide ample support for adopting a shorter provisioning interval for cageless collocation in conditioned space. For example, after thorough review the Public Utility Commission of Texas (Texas Commission) determined that while 90 days was a reasonable interval for provision of *caged* collocation, cageless collocation arrangements could routinely be completed in 70 days or less. In addition, the Texas Commission concluded that, if the collocating carrier installs its own bays and racks, which would further decrease the work required of the incumbent LEC, the appropriate interval would be reduced to a mere 55 days.[123]

Industry practice and data also support adopting a 60-day interval. For example, Qwest has committed to provide cageless collocation within 45 days where space and power are available. And, as Rhythms has pointed out in these proceedings, collocation providers that are not incumbent LECs frequently are able to provide cageless collocation within only 14 days of receiving a complete application.[124] Numerous other parties have provided similar supporting

[123] *FNPRM* at ¶ 17.

[124] Rhythms Oct. 19, 1999 Letter, at 6-7.

examples.[125] In sum, it is clear that incumbent LECs can provision cageless collocation in substantially less than the current 90-day interval, and the Commission should adopt a 60-day interval.

2. **Virtual Collocation**. As with cageless collocation, when incumbent LECs provide virtual collocation they avoid construction of a cage and the ancillary tasks involved with its installation. Thus, for the same reasons that a shorter provisioning period is appropriate for cageless collocation in conditioned space, the Commission should adopt a 60-day period for virtual collocation as well.

3. **Augmentations to Existing Physical Collocation Space.** Where a CLEC has existing physical collocation space and requests an augmentation or modification, incumbent LECs should be required to comply with such requests within 30 days unless substantial construction or a structural build-out is required. If substantial construction is required, the interval should be no longer than that for provision of new collocation. In particular, AT&T proposes that certain routine augmentations (*e.g.*, the provision of no more than 28 DS1s or 3 DS3s or additional overhead lighting) should be completed within 15 days. The Commission should also establish that other common, but more difficult, augmentations be classified in a manner similar to the approach adopted by the Texas Commission.

B. Space Reservation

The Commission should also adopt national rules governing space reservation policies to limit the ability of incumbent LECs to continue to discourage competitive market entry by using space reservation to delay and disadvantage would-be market entrants. The

[125] *See FNPRM* at nn.7 & 44.

Commission should follow the general approach taken by the Texas Commission and other state PUCs in formulating national space reservation rules and periods.[126]

As numerous parties to these state proceedings have correctly argued, space reservation periods for the various classes of equipment should be set based on a variety of factors, including engineering limitations (*e.g.*, maximum viable distance between related equipment), relative scalability and environmental constraints of the various types of equipment, all viewed with an eye toward relevant technological and market developments.[127] Although far from a precise formula, consideration of these factors will allow the Commission to set rational space reservation periods that will adequately address the need of new market entrants to obtain collocation space, while at the same time preventing the use of space reservation to impede competition and balancing the legitimate needs of ILECs and CLECs to reserve space for such periods of time as will allow them to make plans for expansion and ensure that they will have sufficient space to provide future service.

The principal engineering constraint relevant to determining appropriate space reservation periods is the requirement that certain types of related equipment be located within a certain distance of each other. This, of course, raises the legitimate concern that space in the necessary location (*i.e.*, within the requisite distance of other equipment) might be exhausted or hoarded, leaving no opportunity for future expansion.[128] Thus, for example, transport equipment

[126] *See FNPRM at* ¶ 117 (summarizing Texas Commission approach).

[127] Technological developments will likely decrease the relative size of various types of equipment, thus partially mitigating the need for long space reservation periods by allowing capacity growth through equipment upgrades rather than expansion. For example, current DCS equipment provides approximately four times the termination capacity as the equipment of precisely the same size built just three years ago.

[128] Sprint Petition at 7-9; *see also* AT&T Comments at 2 (urging that where an incumbent LEC claims that space is exhausted at a particular premises, the state commission should be required

– which has almost no significant distance constraints – merits a shorter reservation period than most switching equipment, which has substantial distance limitations.

Accordingly, AT&T proposes the following equipment categories and space reservation periods.

1. **Transport Equipment.** As noted above, intra-office distance limitations are not a significant constraint on the placement of transport equipment. Moreover, no other relevant factors would appear to warrant a lengthy reservation period. Accordingly, AT&T proposes that transport equipment be subject to a one-year reservation period.[129]

2. **Digital Cross-Connect Systems (DCS)** While DCS equipment is constrained by certain distance limitations, rapidly increasing capacity currently allows LECs to use the existing space much more efficiently. In just three years, the average termination capacity of DCS equipment has quadrupled. Inasmuch as LECs can increase capacity by 400% without using any additional space, there is less need for a lengthy space reservation period. Accordingly, AT&T believes that the three-year period adopted by the Texas Commission is the most appropriate.

3. **Switching Equipment.** Although switching equipment does have distance constraints, it also has the countervailing advantages of being scalable and modular (allowing such equipment to be split up and installed in areas too small to be used for larger equipment, such as the MDF) and of requiring little more than adequate HVAC and power. For

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to ensure that space reservations by the incumbent LEC or its affiliates are limited to one year and justified by specific business plans); *Rhythms Oct. 19, 1999 Letter*, *supra* note, at 9 (incumbent LECs' practice of reserving central office space for three or more years is anticompetitive and problematic for DSL carriers, such as Rhythms, that are only two years old).

[129] Notably, several state commissions have adopted a one-year period for transport equipment. *See FNPRM* at¶ 51.

these reasons, AT&T believes that the three-year period adopted by the Washington commission to be the most appropriate.[130]

CONCLUSION

For the foregoing reasons, the Commission should adopt rules governing collocation as described above.

Respectfully submitted,

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October 12, 2000

[130] *FNPRM* at ¶ 51.

ATTACHMENT 3A

Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matters of	)	
	)	
Deployment of Wireline Services Offering Advanced Telecommunications Capability	)	CC-Docket No. 98-147
	)	
and	)	
	)	
Implementation of the Local Competition Provisions of the Telecommunications Act of 1996	)	CC Docket No. 96-98

DECLARATION OF JOSEPH P. RIOLO

IV. QUALIFICATIONS ON BEHALF OF AT&T CORPORATION

1. My name is Joseph Riolo. I am an independent telecommunications consultant. My business address is 102 Roosevelt Drive, East Norwich, New York 11732. I submit this declaration in support of AT&T in the above-captioned proceeding.

2. My practice currently focuses on infrastructure design and deployment, and construction and costing with regard to the local loop.

3. I have submitted expert testimony on matters related to telephone plant engineering in California, Delaware, Florida, Hawaii, Illinois, Indiana, Iowa, Maine, Maryland, Massachusetts, Michigan, New Jersey, New York, Ohio, Pennsylvania, Virginia, West Virginia, Wisconsin, the District of Columbia, and before the FCC. I have personally engineered all manner of outside plant including underground, aerial and buried plant in urban, suburban and rural environments. I have engineered copper and fiber plant as well as provisioned analog and

digital services. I have participated in the design, development and implementation of methods and procedures relative to engineering planning, maintenance and construction.

4. During the course of my career, I have had opportunities to place cable (both copper and fiber), splice cable (both copper and fiber), install DLC, test outside plant, and perform various installation and maintenance functions. I have prepared and awarded contracts for the procurement of materials. I have audited and performed operational reviews relative to matters of engineering, construction, assignment, and repair strategy in each company throughout the original 22 operating companies of the Bell System. I have directed operations responsible for an annual construction budget of $100 million at New York Telephone Company. My responsibilities included, but were not limited to, engineering, construction, maintenance, assignment and customer services. This experience was obtained while holding the following positions related to the provision of local telephone outside plant facilities:

5. Between 1987 and 1992, I was the NYNEX Engineering Director-Long Island. In that position, I was responsible for budgeting, planning, engineering, provisioning, assignment and maintenance of telecommunications services for all customers on Long Island, N.Y.

6. Between 1985 and 1987, I was NYNEX District Manager-Midtown Manhattan. I was responsible for budgeting, planning, engineering, provisioning, assignment and maintenance of telecommunications services for all customers in Midtown Manhattan.

7. Between 1980 and 1985, I was NYNEX District Manager-Engineering Methods. In that capacity, I was responsible for the design, development, implementation and review of all outside plant methods and procedures for New York Telephone Company. Additionally, I was

responsible for the procurement of all outside plant cable and apparatus for the New York Telephone Company.

8. Between 1978 and 1980, I was an AT&T District Manager, responsible for the design, development and documentation of various Bell System plans, and for audits and operational reviews of selected operating companies in matters of Outside Plant engineering, construction, assignment and repair strategy. I also served as the Project Team Leader at Bell Telephone Laboratories for the design and development of functional specifications for mechanized repair strategy systems.

9. Between 1976 and 1978, I was District Manager-Outside Plant Analysis Center for New York Telephone Company. I was responsible for the analysis of all outside plant maintenance reports and the design, development and implementation of related mechanized reporting, analytical and dispatching systems. I was also responsible for the procurement of all outside plant cable and apparatus for the New York Telephone Company.

10. Between 1962 and 1978, I held a variety of technical and engineering positions of increasing responsibility at New York Telephone and Bell Telephone Laboratories. During 1967 and 1969, I was on military leave of absence from New York Telephone while serving in the U.S. Navy. I hold a B.S. in Electrical Engineering from City College of New York, and have taken a variety of specialized courses in telecommunications since college.

II. PURPOSE AND SUMMARY OF THE DECLARATION

11. In my declaration, I explain how the traditional ILEC loop architecture was initially designed to accommodate analog voice service. In particular, I detail how the ILECs

gradually introduced efficiencies into the traditional loop architecture, such as digital loop carrier ("DLC") systems at the remote terminal that used multiplexers and other electronics and the addition of high-capacity feeder plant, in order to enhance the transmission functionality of the loop to better accommodate voice service. Even with significant gains in technology that greatly improved the efficiencies for transmitting voice service, however, the traditional ILEC loop architecture could only support transmission rates of 56 kpbs (nominally) in best-case configurations.

12. As consumer demand for bandwidth-rich data services grows, the inherent constraints in the ILECs' traditional loop architecture have caused the ILECs to explore and implement a "next generation" architecture that better utilizes the full transmission functionality of both the low and high frequencies of the local loop in order to provide a wider range of telecommunications services to a broader cross-section of end-users. In particular, I discuss how the ILECs have enhanced their loops by incorporating a much greater use of fiber, introducing splitting and additional multiplexing functions at remote terminals and additional demultiplexing functions at the central office and elsewhere. These loop enhancements have made it possible to greatly increase and improve the transmission functionality of the loop. Indeed, the introduction of next-generation architecture permits ILECs and their data affiliates to provide a whole host of new services, and higher-quality existing services, to their customers while also increasing the ILECs' own economies in their loop plant.

13. I also explain that the transmission functionality provided in next generation RT architecture is no different than that the transmission functionality delivered in a more traditional DLC architecture. Indeed, none of the adjustments that the ILECs are making alter the basic

characteristics of the unbundled loop element that the Commission has recognized and incorporated into its current unbundling rules. First, the loop still remains the essential pathway between the subscriber's premises and the central office. Second, the loop configuration for next generation architecture is no different: a copper pair from a customer's premises to a remote terminal; fiber from the RT to the central office; and electronics to manage the efficient use of the transmission media. Third, the function of the loop between the customer's premise and the central office remains straightforward and unchanged: it is the transmission functionality necessary for retail customers to send and receive information between their locations and the network of the service provider.

14. Next, I describe how the loop transmission functionality in next generation RT architecture encompasses the entire loop, including: a) a copper pair from a customer's premises to a remote terminal; 2) fiber from the RT to the central office; and 3) all attached electronics necessary to manage the efficient use of the transmission media, including, but not limited to: line cards, DSLAMs, and other remote terminal electronics, ILEC-owned line splitters, and the statistical multiplexing functionality of ATMs.

15. Finally, because next generation RT architecture is being deployed closer to customers, I explain the reasons why continuation of CLECs' right to access the entire loop is the only viable option that will enable CLECs to compete in the mass-market. In particular, I explain why, in a next-generation RT architecture, remote terminal collocation and spare copper solutions are insufficient to support a competitive marketplace. For example, space constraints, severe diseconomies of scale and other limitations lead to the inevitable conclusion that, at its

best, remote terminal collocation will be used only in isolated circumstances, and will never be able to support mass-market competition. I also explain that spare copper facilities that extend between the central office and the customer's premises are not substitutes for CLEC access to the full capabilities made possible by the use of shorter copper runs, signal splitting at the RT and the multiplexing of voice and data bit streams onto fiber from RTs to an ILEC central office, all of which are part of the new loop architecture.

16. Accordingly, I recommend that the Commission categorize DSLAMs, especially those in remote terminals, as part of the electronics used to support the loop element, and to otherwise retain its current rules that entitle CLECs to obtain access to all "attached electronics" used to support the basic functionality of the loop.

III. A TECHNICAL LOOK AT TRADITIONAL AND NEXT-GENERATION-ILEC LOOP ARCHITECTURE.

A. Traditional ILEC Loop Architecture Was Designed to Accommodate Analog Voice Service and Is Ill Equipped to Meet Consumer Demand for High-Bandwidth Services.

17. The ILECs' traditional loop architecture was designed to handle voice communications, and it principally employed analog technology that uses a pair of "dumb" copper wires connecting the customer to the central office. At the central office, ILECs connect the copper and add functionality in the form of circuit switches, test capabilities, new switching software, and out-of-band network signaling. The loop occasionally used pair gain or channelization technologies that employ devices at the customer premises and corresponding devices at the central office. Both pair gain and channelization enhance the transmission functionality of the loop through use of multiplexing technology.[1]

[1] Both single-channel and multi-channel systems were usually used in congested areas to defer the need for new telephone cable installations. The single-channel systems provide an

18. Until around 1960, interoffice facilities were typically analog copper in nature. At that point in time, digital technology was first introduced into the interoffice plant. While still a copper based technology, it took advantage of pulse code modulation techniques, otherwise known as "T-1," to digitize the signal and to place multiple signals onto a single facility. The construction of interoffice copper cable plant is costly because it is extremely labor intensive and requires support structure (*i.e.*, poles, conduits) for its entire routing, which is relatively lengthy as compared to subscriber plant. For this reason, engineering economics heavily favored the use of electronics and multiplexing in lieu of a total copper solution in the interoffice network.

19. In the 1970s, optical transmission technologies were introduced into the interoffice plant to enhance transmission functionality, improve the quality and reliability of the network, and reduce network costs. Today, interoffice plant consists almost entirely of fiber optics.

20. In many respects, the ILECs' outside service plant -- the facilities between the central office and the customer -- is no different from their interoffice facilities. Indeed, the same efficiencies that have been, and continue to be, introduced into interoffice facilities are also being deployed in outside service plant, although at a different pace. Originally, outside service

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additional channel by using a frequency spectrum above the voiceband. The frequencies commonly used were 28 kHz toward the station and 76 kHz toward the office. The multi-channel systems were used in low growth areas, typically on long loops. They furnish four to eight channels on a single cable pair. Unlike the single-channel systems, they do not attempt to use the physical cable pair as a voiceband path. Rather, they provide a concentrated remote terminal where customer connections are made, or a distributed remote terminal arrangement where customer connections are made in several locations along the same system. They generally operate with double wideband AM signals, using transmitted carriers at 8 Khz intervals in a band from 12 to 156 kHz. The carrier terminal and intermediate repeaters and the telephone are all powered by direct current sent over the carrier pair. *See* Declaration of Thomas Hill and Robert Frontera ("Hill/Frontera Decl.") for a discussion of multiplexing functionality.

plant consisted largely of copper pairs. In the 1970s, however, the traditional loop architecture was supplemented by the introduction of digital loop carrier "DLC" equipment in the ILECs' outside plant. DLC systems digitally encode and multiplex the traffic from subscribers' loops into DS1 (or higher) level signals[2] to provide more efficient transmission over the feeder facility or to extend the range traditionally permitted by copper loops that employ analog signals.[3] When DLC is used, analog signals are carried from customer premises to a remote terminal ("RT") where they are: (1) converted to digital signals; (2) multiplexed with other signals; (3) often converted from electrical to optical signals; and (4) carried over high-capacity feeder facility (generally fiber) to the ILEC central office. At the central office, a reverse process takes place in some or all of the aforementioned stages. The most common form of multiplexing for voice traffic in a DLC arrangement is time division multiplexing ("TDM"), which assigns a particular time slot, or position in a cycle, of fixed information capacity (64 kilobits) to create the communications path within a single physical facility.[4]

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[2] DS1 channels carry 1.544 megabits per second ("Mbps") of data, the digital equivalent of twenty-four 64 kbps analog voice channels.

[3] The two traditional DLC systems are universal DLC ("UDLC") and integrated DLC ("IDLC"). UDLC, the older of the two systems, is not directly integrated with the switch. Thus, the ILEC's central office equipment (i) converts optical to electrical signals in fiber driven systems and (ii) converts digital signals back to analog before the signals are delivered to the main distribution frame. IDLC is integrated with the switch at the DS1 level and provides a direct, digital interface to a digital central office switch. As the Commission is aware, the procedure to unbundle IDLC is different, because, unlike UDLC traffic, IDLC traffic is not demultiplexed and converted back from digital to analog before it reaches the central office switch. Exhibit A, attached to this declaration, illustrates an ILEC's loop architecture supplemented by UDLC and IDLC.

[4] TDM is a technique for transmitting data, voice and/or video signals simultaneously over one communications medium by quickly interleaving a piece of each signal, one after another, in a fixed time sequence. TDM "samples" each voice conversation, interleaves the result of each sample with the results of sampling other conversations, and sends them on their way in a structured sequence. At the other end of the loop, the individual signals are "demultiplexed," which means they are reconstructed using a similar process in reverse

21. In a DLC arrangement, the loop from the subscriber's premises begins as a copper distribution pair and runs to the field side of the ILEC's Serving Area Interface ("SAI", which is sometimes referred to as a Feeder Distribution Interface or "FDI"), where it is connected to a copper feeder pair on the central office side of the SAI.[5] The copper feeder pair is then delivered to a remote terminal, which may be a controlled environmental vault ("CEV"), a hut, or a cabinet. A general description of each type of remote terminal is attached to my declaration as Exhibit B.

22. The copper feeder pair from the SAI is then hardwired to the DLC system within the remote terminal. The DLC equipment converts the analog signals on the copper from the subscribers' premises to digital format. The individual subscriber signals are then interleaved (multiplexed) into high speed signals and then, in most instances, converted from electrical to optical signals. This enables the signals to be transmitted to the central office, often over fiber facilities.[6] The DLC equipment typically includes a common control assembly ("CCA"),[7] which

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order. Each communication is placed on a time slot (or position in a cycle) of fixed duration and fixed position on the loop facility. The time duration of the slot limits both voice and data transmissions to 64 kbps. The multiplexer and demultiplexer at the remote terminal and central office both need to ensure that the particular time slot (or position in a cycle) corresponds to the appropriate customer.

5 The SAI is the interface point between the ILEC's distribution and feeder cable. Feeder cables terminate on a SAI in each serving area, where they are cross-connected to copper distribution cables. A single remote terminal may support several SAIs.

6 DLC systems employing copper feeder and T1 technology still use an electrical signal.

7 The Common Control Assembly ("CCA") typically contains equipment groups necessary to provision the DLC system, such as the common optics, common electronics and common support features. The common optics equipment group may include optical tranceivers that provide the optical-to-electrical conversion as well as the interface to the common electronics. The common electronics equipment group includes SONET formatters and Time Slot Interchangers ("TSIs"), which interface with the Channel Bank Assemblies ("CBAs"). System protection switching is also contained in the common electronics equipment group.

provides the capabilities needed to operate the entire DLC system, and channel bank assemblies ("CBAs"),[8] which provide the interface between the end user cable pairs and the DLC equipment.

23. The ILEC loop plant, regardless of architecture, can accommodate low-speed data transmissions. Even with significant gains in modem technology, however, the ILECs' traditional loop plant, absent improvement in the transmission equipment deployed, can only support data rates of 56 kpbs (nominally) in best-case configurations. Advances in design and large-scale integrated circuits have simultaneously increased speed and reduced modem cost. Modems built to the V.90 standard are intended to take advantage of the fact that -- except for analog subscriber lines to end users -- telephone networks already incorporate digital technology. As a consequence, analog transmission facilities are usually encountered in the link from the end user to the central office and, therefore, only one analog to digital Codec (A/D conversion) should be necessary. Thus, in the most favorable situation, performance-limiting impacts of spurious electrical signals (or noise) would only be encountered in the upstream path (from the user to the central office) due to the necessary A/D conversion. The effect would limit the upstream to V.34 speeds or 33.6 kbps in the ideal case and 56 kbps in the downstream direction (since the signal ideally would be digital from the ISP all the way to the end user modem).

The common support group includes alarms, common power supply, and maintenance and testing features.

8 The CBAs house various channel units assigned to individual customers, as well as common electronics used by all customers served by the CBA. Typically, the CBA can be wired to accommodate both low- and high-frequency spectrum traffic. The common CBA units derive the correct power options to be supplied to the CBA plugs as well as the interface to the CCA TSI units. Ringing generator units, metallic test access units and communications interface units may also comprise the CBA common units.

Given the varied conditions and loop lengths that exist in the plant, the aforementioned speeds are optimistic.

24. The explosive growth of the Internet, e-commerce, telecommuting, and ready access to information and entertainment has resulted in a dramatic increase in the number of customers that desire high-speed data service. As a result, in the past few years, consumer demand for high-speed Internet access capabilities has increased exponentially. In particular, demand for increasingly rich graphics, streaming audio, and now even streaming video applications are continuing to make consumers expect more and more bandwidth.

25. The introduction of xDSL technology has significantly increased the copper loop's ability to carry data transmission.[9] xDSL technologies are transmission technologies used on circuits that run between a customer's premises and the central office. xDSL technologies increase the ability of the standard twisted pair to carry high capacity data transmission by expanding the usable bandwidth of the copper line. Traditionally, xDSL technologies have been deployed on loops that are copper end-to-end from the central office to the customer premises ("home-run copper").

26. The ILECs' traditional architecture is ill equipped to address more remotely located consumers' demand for increased bandwidth. For example, noise and other signal impairments constrain data bit rates on longer loops. Because performance of xDSL technologies are affected by the electrical characteristics of the loop (including length), some loops cannot use xDSL technologies at all; others are constrained to rates that are still below

[9] "DSL" is the acronym for Digital Subscriber Line. "x" is a variable, meant to encompass the various types of Digital Subscriber Line technologies and is used when referring generally to DSL.

what is needed to take full advantage of the possibilities of the Internet. As noted below, however, with the deployment of transmission equipment outside the central office by incumbent LECs, some types of DSL may be feasible on hybrid loops that are copper from the customer's premises to an intermediate equipment location -- the RT -- where signals are processed, multiplexed and transmitted over fiber optics from the RT to the central office.

B. The ILECs Have Responded to Consumer Demand for Bandwidth-Rich Data Services Through the Deployment of Next-Generation Architecture, Which Greatly Enhances the Transmission Functionality and Economics of the Local Loop Plant.

27. The inherent transmission constraints in copper conductors caused ILECs to look for ways to better utilize the full transmission functionality of their local loops so that they could meet consumer demand for bandwidth-rich services without replacing the entirety of their loop plant. In response, the telecommunications equipment manufacturers have made great advances in digital signal processing, opto-electronics, large-scale and very large-scale integration, environmental hardening, and power supplies.

28. Thus, consumer demand, coupled with the miniaturization of electronics, increased equipment capabilities and the growing environmental "hardness" of electronics used in such equipment -- along with the rapidly declining costs of such equipment -- has resulted in accelerated deployment of fiber in the ILECs' outside plant and electronics in remote terminals.[10] SBC has announced ambitious plans to deploy an overlay fiber/remote terminal electronic network to reach some 80% of end users in its service area within 3 years.[11] Similarly, other

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[10] *See generally* Public Forum: Competitive Access to Next Generation Remote Terminals, CC Docket 96-98 et al. (May 10, 2000) ("NGRT Public Forum").

[11] *SBC to Offer DSL Through Neighborhood Gateways*, SBC Press Release (September 8, 2000) <http://www.sbc.com/News_Center/Article.html?querry_type=article&query =2000908-01>; Dick Kelsey, *FCC Approves SBC Neighborhood Gateway Plan*, Newsbytes (September 8, 2000) <http://www.newsbytes.com>.

major ILECs have publicly acknowledged more general plans for wide-scale deployment of this technology to provision broadband services.[12]

29. As a result, outside plant is rapidly employing digital end-to-end and the digital signals are more frequently carried some or all the way in an optical format. All this means higher and higher transmission rates from the customer premise to the network (where all service functionality resides) are becoming feasible.

30. These developments have enabled ILECs to implement a loop architecture that generally has the following characteristics:

- Much shorter runs of copper between the customer's premises and the first point at which customer communications are enhanced by transmission electronics;
- Electronics (and opto-electronic conversion) at the RT, where analog voice signals from the customer's premises are converted to digital;
- Splitting customer data and voice streams and application of multiplexing strategies best meeting the demands of the particular communications;[13]
- Fiber between the RT and ILEC central office (or other ILEC location) possessing very high transmission capacities; and
- Electronics at the ILEC central office end of the loop to demultiplex the aggregated traffic, so that voice traffic may be delivered to circuit switches and data traffic may be delivered to diverse carriers and Internet service providers ("ISPs").

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[12] *Industry Debates Access to ILEC 'Remote Terminals,'* Communications Daily (May 11, 2000); *Verizon Deploys Fiber Optics, Electronics, Bringing Additional Advanced Technology Services to Washington County*, Verizon Press Release (July 19, 2000) <http://newscenter.verizon.com/proactive/newsroom/release.vtml?id=40908>.

[13] ILECs frequently also place TDM signals (voice) on one fiber and ATM signals (data) on a separate fiber. ATM and TDM signal can co-exist on the same fibers simultaneously in several ways. It is technically feasible to carry TDM time slots within an ATM format. Another technically feasible scheme would involve wave division multiplexing (WDM) wherein each type of signal travels on the same fiber(s) at different wavelengths, e.g. TDM @ 1550 nm and ATM @ 1310 nm.

31. Exhibit C to this declaration illustrates an ILEC's typical implementation of such a loop architecture. Like the DLC systems described above, the copper distribution pair[14] running from the customer's premises is typically connected to the fiber feeder portion of the loop at, or near, the remote terminal.[15] However, in a forward-looking configuration with DSL-compatible DLCs, the copper segment of the loop is typically connected to a plug-in card ("line card") with integrated DSLAM/splitter functionalities. The line card plugs into one of the channel banks in the DLC equipment in the ILEC's remote terminal. The line card is the point at which the voice and data signals are separated and separately multiplexed onto one or more fiber feeder facilities, which transmit the signals back to an ILEC central office on separate pathways.

32. These transmission electronics introduced into the RT permit customer information to be handled based upon the differing characteristics and needs of voice and data traffic. For example, voice traffic is low density (*i.e.*, sends a relatively small amount of information) but extremely intolerant of latency (*i.e.*, delay). In contrast, data traffic often has high information density for short periods of time but can be somewhat tolerant of latency. Thus, the most efficient handling of voice streams and data streams may require that each be multiplexed differently. As noted above, the most efficient type of multiplexing for voice traffic

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[14] The Distribution Plant fed by DLC is designed in accordance with Carrier Serving Area (CSA) guidelines. Briefly, CSA guidelines state that the copper distribution cable shall be non-loaded (free of load coils) and distance limited (e.g. < 9 kft of 26 gauge copper, <12 kft of 19, 22, or 24 gauge copper). Moreover, the distribution cable shall not contain more than 2,500 feet of bridged tap in total, and no single bridged tap may exceed 2,000 feet. Thus, all end users served from a remote terminal via DLC should have loops free of impediments to digital transmission and the longest loop will not exceed 12 kft (or 9 kft in the case of 26 gauge copper).

[15] As noted above, DLC systems have, for some years, applied digitization to voice waveforms in the loop.

in traditional networks is generally TDM. In contrast, it is frequently more efficient to use statistical multiplexing for data traffic.[16]

33. At this point, fiber feeder is introduced into the loop, running from the remote terminal to an ILEC central office that carriers separate signal streams for aggregated voice and data traffic.[17] In the remote terminal, the splitter directs the voice stream to the fiber feeder facilities that will ultimately connect to a circuit switch in the central office; similarly, it directs the data stream to an ATM-like device at the central office. The bitstream carrying data traffic can be also combined with other data and voice traffic in the ILEC's SONET equipment at the remote terminal and carried on the same fiber(s).[18] Fiber feeder facilities run between the SONET equipment at the remote terminal and SONET equipment at the ILEC's serving central office.

34. Fiber feeder cable is generally an inch in diameter, regardless of the number of strands. Through the use of innerducts, the ILEC can place up to four fiber cables in the same conduit by partitioning the larger conduit into several smaller diameter conduits.[19] The conduit

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[16] Statistical multiplexing differs from TDM in that the share of the available bandwidth allocated to a given user varies dynamically. Statistical multiplexers fill available bandwidth based on the priority of the services awaiting transmission. If there is no contention for the facility at a particular point in time, a low priority communication will be sent, even though the end user has not "reserved" all of that capacity.

[17] If a single fiber facility is used, both types of traffic are brought to the customer's serving central office. If two facilities are used, the voice traffic is brought back to the customer's serving central office and the data traffic may be brought to a different location, depending on the ILEC's network design.

[18] There is no inherent technical reason why the ILECs need to separate the voice and data traffic over the same fiber. *See supra* n.13.

[19] In contrast, a copper cable occupies the entire conduit duct and provides only 1100 pairs if 22 gauge, 1800 pairs if 24 gauge, and up to 3,600 pairs if 26 gauge. In addition, copper cables are much heavier and much more labor intensive. For example, a 22 gauge copper cable pair

(which has a diameter of 3.5" to 4.0") is run underground to the ILECs' central offices. In an urban environment, the fiber is usually underground for thousands of feet before it enters a central office. In a suburban neighborhood, the fiber is typically underground for approximately 1,000 feet. In a rural area, the fiber may be underground for only a very short distance.

35. At the central-office, the ILEC introduces electronics that are required to demultiplex the separately aggregated voice and data traffic, so that voice traffic can be directed to circuit switches and data traffic can be directed to carry data switches that, in turn, route the communication to diverse end points. At the central office, the ILEC introduces electronics that terminate the feeder facility and 1) connects the TDM signal to the local digital circuit switch; 2) connects the ATM signal to a device that separates each CLEC's traffic out from the commingled packets carried over the feeder facility and aggregates each CLEC's packets onto a facility that connects to the CLEC's data network.[20] This is the first centralized point at which the ILEC can deliver an individual CLEC's data traffic to the competitor.

C. The ILECs' Next Generation Architecture Holds the Potential for Great Consumer Benefits but Also the Danger of Great Competitive Harms.

36. Increasing the use of fiber and placing the electronics closer to retail subscribers has made it possible to increase and improve the transmission capacity of loops for all customers,

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weighs about 5.7 pounds per foot. Depending upon whether the area is urban, suburban, or rural, copper cable may require splice points every 300 to 1,000 feet. Fiber, on the other hand, weighs only 0.13 pounds per foot (for a cable containing 108-216 fiber strands), and may run for 20,000 feet between splice points. In addition, the FCC Synthesis Model indicates that 26 gauge (2400 pair) copper feeder costs $16.94 per foot while 24 strand fiber costs only $1.79 per foot. Thus, the conductor cost for copper is roughly nine times the cost of fiber. While fiber incurs additional costs for central office electronics, those electronics permit much greater transmission capacity (by many orders of magnitude) than does copper.

[20] In circumstances where the CLEC opts to deliver the traffic to a remote location, the concentrated CLEC signal would be delivered to the interoffice network for subsequent delivery to a "Gateway" node or location.